U.S. NAVY SHIPBOARD DAMAGE CONTROL: INNOVATION AND IMPLEMENTATIONAN DURING THE INTERWAR PERIOD

A thesis presented to the Faculty of the U.S. Army
Command and General Staff College in partial
fulfillment of the requirements for the
degree

MASTER OF MILITARY ART AND SCIENCE
Military History

by

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Fort Leavenworth, Kansas
2014-02

REPORT DOCUMENTATION PAGE	*Form Approved OMB No. 0704-0188*

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
12-12-2014	Master's Thesis	FEB 2014 – DEC 2014

4. TITLE AND SUBTITLE

U.S. Navy Shipboard Damage Control: Innovation and Implementation During the Interwar Period

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

LCDR Jeremy P. Schaub

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

U.S. Army Command and General Staff College
ATTN: ATZL-SWD-GD
Fort Leavenworth, KS 66027-2301

8. PERFORMING ORG REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for Public Release; Distribution is Unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

The United States Navy adopted the fundamentals of modern shipboard damage control from the Germans at the end of World War I. The tremendous survivability of German warships as seen at Dogger Bank and Jutland led the U.S. Navy to study the German model of damage control and ultimately implement changes in ship design, crew training, and shipboard organization to closely mimic the German model. These changes remain largely intact today.

With so much of the Navy's heritage rooted in British tradition and influence, it is remarkable that such an effective force multiplier for survival at sea was learned from the German Navy. This was a time in U.S. military history in which emulation of a former enemy could lead to such widespread and enduring results. The most recent shipboard disasters, those of USS *George Washington*, USS *Cole*, USS *Samuel B. Roberts* and USS *Stark* were all met with herculean efforts of men and women organized, trained, and equipped based on a system of damage control copied from the enemy and implemented nearly a century ago.

15. SUBJECT TERMS

Damage Control, U.S. Navy, Interwar, Battle of Jutland, Revolution in Military Affairs

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. PHONE NUMBER** *(include area code)*
(U)	(U)	(U)	(U)	65	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

MASTER OF MILITARY ART AND SCIENCE

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ABSTRACT

U.S. NAVY SHIPBOARD DAMAGE CONTROL: INNOVATION AND IMPLEMENTATIONAN DURING THE INTERWAR PERIOD, by LCDR Jeremy P. Schaub, 65 pages.

The United States Navy adopted the fundamentals of modern shipboard damage control from the Germans at the end of World War I. The tremendous survivability of German warships as seen at Dogger Bank and Jutland led the U.S. Navy to study the German model of damage control and ultimately implement changes in ship design, crew training, and shipboard organization to closely mimic the German model. These changes remain largely intact today.

With so much of the Navy's heritage rooted in British tradition and influence, it is remarkable that such an effective force multiplier for survival at sea was learned from the German Navy. This was a time in U.S. military history in which emulation of a former enemy could lead to such widespread and enduring results. The most recent shipboard disasters, those of USS *George Washington*, USS *Cole*, USS *Samuel B. Roberts* and USS *Stark* were all met with herculean efforts of men and women organized, trained, and equipped based on a system of damage control copied from the enemy and implemented nearly a century ago.

ACKNOWLEDGMENTS

First and foremost I must thank my wife, Dr. Jehanne Dubrow. She graciously supported my decision to spend a year alone on the Great Planes in order to complete my MMAS. After nine years as a military spouse she is accustomed to a long distance marriage for the sake of war, but it is something else entirely to accept the separation for joint education and another year of school.

Dr. John T. Kuehn, my thesis committee chairman, was instrumental in keeping me on the right path. He always made certain I was asking the right questions and when I was pressed to find the answer, he always provided me with options. His writing experience and knowledge of the interwar Navy were both tremendous resources during my research and writing processes. Michael Cecere, with nearly forty years of naval engineering experience not only provided expert recommendations and advice, but also researched and copied material from the National Archives on my behalf. As if that was not enough he served as a critical reader and editor during the revision process. I am in his debt. Robert Brown and Richard Anderson both gave their time to serve as members of my thesis committee and provided level-headed advice and support during the entire process. Finally, I consider myself lucky to have landed in LTC Christopher Johnson's A221 small group writing seminar. His encouragement and guidance sharpened my writing and helped me keep my focus.

Naturally, all of the errors, typos, and lies are mine and mine alone.

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ACRONYMS

DCA	Damage Control Assistant
HMS	Her Majesty’s Ship
RMA	Revolution in military affairs
SMS	Seiner Majestät Schiff (His Majesty's Ship)
USS	United States Ship.

TABLE

CHAPTER 1

INTRODUCTION

On 22 May 2008 a fire broke out on USS *George Washington* that injured thirty-seven sailors, took nearly twelve hours to extinguish and resulted in over $70 million in repairs. It was one of the largest non-combat fires since the devastating USS *Forrestal* fire in 1967. Key discrepancies in the damage control training program, the maintenance and storage of damage control equipment, and the damage control charts depicting the many compartments in the ship greatly contributed to difficulties in locating and combating the fire.[1]

On 12 October 2000 while at anchor in Aden, USS *Cole* was attacked by Al-Qaeda suicide bombers. The blast killed seventeen crew members, wounded thirty-nine, and created a hole in the side of the ship approximately forty feet in diameter. The valiant efforts of the crew were only possible because of the focused and extensive damage control training conducted by the ship in the months prior to the attack.[2] Strengths and weaknesses of onboard damage control equipment were identified in multiple investigations and reports. Shipboard equipment allowances were changed throughout the Navy as a result of this attack.

USS *Samuel B. Roberts* struck a mine in the central Persian Gulf on 14 April 1988. The blast blew a fifteen foot hole in the hull, flooded the engine room, knocked the

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[1] Frank M Drennan, RADM, USN, *Command Investigation into the Fire that Occurred Onboard USS George Washington (CVN 73) on 22 May 2008* (1 July 2008, Unclassified).

[2] Kirk Lippold, *Front Burner: Al Qaeda's Attack on the USS COLE* (New York, NY: Public Affairs, 2012), 21.

ship's engines from their mounts, and broke the keel of the ship.[3] On 17 May 1987 two Exocet missiles hit USS *Stark* killing thirty-seven sailors, wounding twenty-one others, and causing flooding and fires that burned for almost twenty-four hours.[4] Both of these incidents clearly illustrated the extent of damage that U.S. Navy ships can withstand and survive when a strong ship is crewed with well-trained sailors.

But where did the U.S. Navy learn the tactics and techniques of modern shipboard damage control? Did the U.S. Navy develop them on its own? Did the Navy adapt them from the British Royal Navy as they have so many other tactics and procedures? The answer is found in the unlikely results of the two largest naval battles of World War I. The critical lessons that were implemented and adapted by the U.S. Navy and eventually saved the lives of sailors onboard *George Washington*, *Cole, Samuel B. Roberts* and *Stark* were learned in the North Sea in 1916 from the German Navy.

German warships such as SMS *Ostfriesland* and SMS *Seydlitz* suffered tremendous damage during the battles of Dogger Bank and Jutland but not only remained combat effective, but were quickly repaired and returned to sea after each engagement. The General Board of the Navy and the Bureau of Construction and Repair were innovating after the war and the survivability of the German fleet greatly interested their leadership. At the close of the war, the U.S. Navy sought detailed information regarding German damage control practices. The fundamental damage control principle adopted by

[3] Bradley Peniston, *No Higher Honor: Saving the USS Samuel B. Roberts in the Persian Gulf* (Annapolis, MD: Naval Institute Press: 2006), 125.

[4] Jeffrey L. Levinson and Randy L. Edwards, *Missile Inbound: The Attack on the Stark in the Persian Gulf* (Annapolis, MD: Naval Institute Press, 1997), 36-37.

the Germans–namely that the control of damage takes precedence over all demands in time of war or peace–changed the way the U.S. Navy conducted itself at sea.

A translated copy of the German *Damage Control Regulations* was furnished to all capital ships in the U.S. fleet along with charts and diagrams illustrating the application of the German system. Two Navy boards were appointed to investigate the subject of damage control and make recommendations for the implementation of the German system. Key recommendations from these boards included increased water-tight subdivision, better drainage and cross flooding capabilities, improved shipboard organization and training for damage control. Also recommended were implementing a system of controlling watertight closures prior to going into battle, better tracking and monitoring of damage and efforts to control or repair it, and several other procedures largely corresponding to the German practice.

During the 1920s and 1930s the U.S. Navy implemented and improved upon its new system for damage control. The evidence of the Navy's success came in the remarkable survivability of the carriers USS *Hornet*, USS *Enterprise*, and USS *Yorktown*. While Yorktown in fact sunk at the Battle of Midway, her contribution to the success of that battle was critical. The ability of these ships and their crews to survive heavy damage, maintain combat effectiveness, return to port for repairs and return to battle again was an indispensable contribution to winning the war in the Pacific.

Literature Review

There has been very little written about the origins of modern shipboard damage control. Books, journal articles and even official records focus primarily on the implementation of damage control in World War II. Modern shipboard disasters are also covered, but again, any descriptions of the damage control organization and tactics are relayed in passing and used to tell a broader story about the ship, the crew, and the struggle to survive at sea.

Archival records constituted a large portion of my written sources. Records of the proceeding and hearings of the General Board of the Navy during the interwar period provided a significant window into the churning and innovation of the period. Additional letters, reports, and papers published between the wars added to my primary research.

The most significant portion of my research came from close study of Navy manuals from the period. Early U.S. Navy publications such as *The Stability of Ships and Damage Control*, *Principles of Warship Construction and Damage Control*, and a series of lectures at the U.S. Naval Academy titled simply *Damage Control* proved invaluable for tracing the origins and implementation of modern ship design, construction and organization. Other published primary sources included a number of *U.S. Naval Institute Proceedings* articles that appeared during the interwar period as many of the new changes in shipboard damage control were taking place.

A critical secondary source was Dr. John T. Kuehn's *Agents of Innovation: The General Board and the Design of the Fleet that Defeated the Japanese Navy*. The book examines the Board's role in the innovation and design of the naval fleet during the interwar years. Dr. Kuehn details the struggle for innovation under the constraints of the Washington Naval Treaty and a nation skeptical of war.

Other secondary sources include V. E. Tarrant's *Jutland: The German Perspective*, Andrew Gordon's *The Rules of the Game: Jutland and British Naval Command*, and F. Ruge's profile of SMS *Seydlitz*. These works provided perspective on

British and German damage control during the battle of Jutland and a record of the tremendous damage German war ships were capable of sustaining.

Books such as Kirk Lippold's *Front Burner: Al Qaeda's Attack on the USS Cole*, Levinson and Edwards' *Missile Inbound: The Attack on the Stark in the Persian Gulf,* and Bradley Peniston's *No Higher Honor: Saving the USS Samuel B. Roberts in the Persian Gulf* provide poignant reminders of the critical need for effective damage control today. In addition, these accounts illustrate how remarkably similar modern ship design and damage control organization is to that implemented during the interwar period.

Structure of the Thesis

Chapter 2 examines German warship survivability in World War I. Kaiser Wilhelm sought to build a strong navy capable of challenging British sea power. Ship designs that include extensive watertight subdivision or compartmentalization sacrifice habitability for watertight integrity.

Chapters 3 and 4 focus on three areas: the limited survivability of U.S. warships in World War I, the implementation of the German model into the U.S. fleet, and the innovation in damage control during the interwar period. New ships were designed with increased compartmentalization. Shipboard crews were organized in a manner similar to the German model, and extensive damage control training was implemented into shipboard routines. There is a direct link between German innovation in World War I and the survival of the fleet carriers during the months following the attack on Pearl Harbor. These carriers repeatedly suffered extensive damage, limped back to port for repairs and continued to bring the fight to the enemy. This was a clear indication that the U.S. Navy had learned a valuable lesson from the Germans.

Chapter 5 concludes the thesis with a discussion of revolutions in military affairs. The advancements in tactics, doctrine, organization, and technology all came together to change the way the U.S. Navy conducted damage control. The innovations were not wild leads. The changes implemented by the General Board of the Navy and the Bureau of Construction and Repair were tied to past experience, conceptually sophisticated, and were honestly assed during the interwar period and the early months of the Second World War. Was the innovation in damage control during the interwar period a revolution in military affairs?

CHAPTER 2

THE GERMAN MODEL OF DAMAGE CONTROL

Prior to World War I the German Navy (*Reichsmarine*) understood the critical importance of preserving the buoyancy of its ships and of keeping them as near as possible on an even keel. To this end, the German Navy's ship designers incorporated extensive compartmentalization (watertight subdivisions within the hull of the ship) and carefully and thoroughly trained its sailors. The attitude of the German Navy in this respect is reflected in its *Leckregeln* or *Damage Control Regulations*: "The control of damage in battle supersedes all other requirements and demands above all the faculty of decision and prompt, reliable action. A damage-control service organized and trained from this point of view must also operate perfectly in cases of accidents occurring in time of peace. "[5] Survivability, therefore, was central to German warship construction and the control of damage was fundamental to their design.

The survivability of German capital ships was not an accident. Kaiser Wilhelm II came to the throne in 1888 intent on making Germany a great imperial power. Because of his British ancestry (as he claimed), he loved sailing and the sea and for the first ten years of his reign he argued for a naval fleet commensurate with Germany's growing world power. "When, as a little boy, I was allowed to visit Portsmouth and Plymouth hand in hand with kind aunts and friendly admirals, I admired the proud English ships in those two superb harbours. Then there awoke in me the wish to build ships of my own like

[5] United States Navy Department Bureau of Construction and Repair, *The Stability of Ships and Damage Control* (Washington, DC: United States Government Printing Office, 1931), 1.

these someday, and when I was grown up to possess as fine a navy as the English" In response to this boyhood reminiscence, Chancellor Bernhard von Bülow cautioned Kaiser Wilhelm: "Your majesty, if you describe our fleet, built with such heavy cost, sometimes with danger, so sentimentally, as the outcome of your own personal inclinations and juvenile memories, it will not be easy for you to obtain further millions for naval construction from the Reichstag."[6] At the time Germany faced the financial burden of maintaining the largest and most powerful army in Europe and the Reichstag (German parliament) was reluctant to finance the creation of a large navy.[7]

The Kaiser's plan started to come to fruition in 1897 when he appointed Admiral Alfred von Tirpitz as Secretary of the Imperial Navy. Like Kaiser Wilhelm, Admiral Tirpitz believed that in order to protect the country's trade and colonial expansion, Germany needed a navy "so strong that even for the adversary with the greatest sea power a war against it would involve such dangers as to imperil his position in the world."[8] Tirpitz was able to win over the Reichstag with patience, reason, and more modest proposals than the Kaiser had asked for. He argued in terms of colonial and homeland defense and the protection of critical national interests to convince the Reichstag of the need to significantly increase the size of the navy.

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[6] Robert K. Massie, *Dreadnought: Britain, Germany, and the Coming of the Great War* (New York: Random House, 1991), 151.

[7] V. E. Tarrant, *Jutland: The German Perspective: A New View of the Great Battle, 31 May 1916* (Annapolis, MD: Naval Institute Press, 1995), 9.

[8] Tirpitz Papers, German Ministry of Marine MSS, Bundesarchiv-Militararchiv, Freiburg im Breisgau.

Admiral Tirpitz believed that the main objective of naval warfare was annihilation of the enemy and that that was only possible by sinking the enemy's ships. As long as a ship remained afloat, she retained some measure of fighting value. Preferring strength over numbers, Tirpitz sought to increase the buoyancy of the planned German ships to increase their survivability and their fighting value. Ships built before 1906 had very little underwater protection and could typically be sunk by a single torpedo. In 1906 Tirpitz directed experiments to increase the survivability of the fleet he was planning. Unwilling to sacrifice modern ships for testing and unable to learn enough from ships built from outdated designs, Tirpitz had special ship sections purpose-built to study the effect of live underwater explosions on ships' hulls.[9] These experiments continued for years, cost millions, and heavily influenced German ship design and construction.

One result of these experiments (still in use in U.S. Navy warships) was the discontinuation of connecting compartments below the waterline. Tirpitz stated, "We had to abandon a number of well-known qualities and conveniences which were common in the peace-time navy for the sake of effectiveness in battle. The complete absence of doors, for example, in compartments below the water line was inconvenient. Such a thing however, might at a critical moment decide the ship's fate."[10]

In his memoirs, Tirpitz recounted the early successes of his new design: "The buoyancy which was attained by our system stood the test. In contrast to the British ships,

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[9] Alfred von Tirpitz, *My Memoirs, by Grand-Admiral von Tirpitz* (London: Hurst and Blackett, 1919), 132.

[10] Ibid., 133.

ours were well-nigh indestructible."[11] Although Tirpitz was overstating his case here, he cited the increased survivability of specific ships to support his claims:

> The whole English fleet went on hammering the little *Wiesbaden*, and yet the poor ship would not sink. Although the *Mainz* was shot to pieces and torpedoed, she could not be sunk until an officer and torpedo artificer, after everybody else had left the ship, opened the torpedo tubes, and went down with the ship. The distinguished commander of the *Emden* put his ship at a coral reef under full steam, and yet the inner structure stood firm. It was astounding what out ships could stand in the way of mines and torpedoes without sinking. During Admiral v. Rebeur's attack upon Imbros, the *Goeben* struck three heavy mines, but she was still able to return to the Bosphorous under her own steam, whilst a modern English ship of the line, the *Audacious*, sank in the Irish Sea after striking one single mine. It was only our older ships, like the *Pommern* and the *Prinz Adlabery*, built at a time when our experiments on buoyancy had not been concluded, that showed less power or resistance.[12]

The newly designed ships proved capable of suffering damage and still maintaining their combat power.

The first class of German dreadnoughts was laid down in 1907 and was designed by Hans Bürkner. Bürkner's ship designs centered on Tirpitz's belief that capital ships must, above everything else, be able to remain afloat and stay in the fight. He placed greater emphasis on armor protection and defensive qualities than on armament. Bürkner designed his ships with optimum underwater protection including extensive internal watertight subdivision below the waterline to minimize progressive flooding associated with mines and torpedoes. This design became the basis of German ship design throughout the war. Tirpitz, again, emphasized this design philosophy in his memoirs: "The supreme quality of a ship is that she should remain afloat, and, by preserving a vertical position, continue to put up a fight; in this respect the English navy was so much

[11] Ibid., 132.

[12] Ibid., 133.

behind ours that the difference in this quality alone might decide the issue of a naval engagement."[13]

German ships of this period compared well to ships of the same class among the Allied Navies. Technological advances such as the main reduction gear in the *Bayern* class (1916) that allowed the turbines to spin at their most efficient speed while stepping down the revolutions to also allow the propellers to spin at theirs, were offset by the fact that the *Bayern* still relied on coal.[14] One exception to this general parity was especially apparent to the crews of most German warships. The Germans did not envision long war cruises by heavy ships and so designed them for operations with a lesser degree of habitability.

German capital ships displaced more tonnage owing to the thick and heavy armor plating at the waterline. Unlike American and British ship designers, Bürkner ran the armor belt the entire length of the water line. In order to build a fleet strong enough to confront the Royal Navy, Bürkner concentrated his efforts on provisions that made his ships resistant to sinking and fire. Special measures were taken to ensure the safety of the critical controlling stations within the ship and survivability, not numerical superiority was the key. By building stronger ships, the German navy achieved an important counterpoint for its inferior numbers against the British fleet.[15] Tirpitz stated that what

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[13] Ibid., 133.

[14] Erich Gröner, Dieter Jung, and Martin Maass, *German Warships, 1815-1945* (Annapolis, MD: Naval Institute Press, 1990), 28-29.

[15] Tirpitz, *My Memoirs, by Grand-Admiral von Tirpitz*, 134.

Germany sought was a fleet of ships so strong that it presented a certain risk even for the British fleet.[16] Of course, heavier armor came at the cost of smaller, shorter ranged guns.

Many sceptics did not understand the power of the new German fleet until after the Battle of Jutland. Admiral Jellicoe stated in his report of the battle: "The German ships, far more frequently hit by gunfire, torpedo, or mine than many of our ships that sank were yet taken safely into port."[17] It was this survivability that caught the attention of U.S. Navy officials. SMS *Seydlitz,* a 25,000 ton German battle cruiser, took two hits from heavy guns, had both after turrets burned out and suffered heavy personnel losses at the 24 January 1915 battle of Dogger Bank.[18] Throughout the entire engagement she continued to return fire from her remaining turrets and after the engagement made it back to port on her own power. It was the ability of the ship to remain on a nearly even keel that allowed her fire control officer and gun crews to continue firing her remaining guns. This is how damage and flooding control can impact fire control. In April 1916, *Seydlitz* struck a mine and only returned to port when it became clear that the 1400 tons of water she took on prevented her from making sufficient speed to remain with the fleet. At the battle of Jutland (31 May–1 June 1916) *Seydlitz* survived twenty-one large caliber shell hits, a torpedo hit, and two burned out turrets. In spite of the 5300 tons of water in her hull, she again returned to port on her own power. She was repaired and ready for action

[16] Ibid., 123.

[17] John R. Jellicoe, "The Battle of Jutland: Account by Admiral Jellicoe," *The Battle of Jutland, 31 May-1 June 1916* (Newport RI: Naval War College, 1920), 106.

[18] F. Ruge, *Warship Profile 14: SMS Seydlitz: Grosser Kreuzer 1913-1919* (Windsor: Profile Publications, 1972), 25.

three and a half months later. *Seydlitz* was scuttled by her own crew at Scapa Flow on 21 June 1919.[19]

Captain George von Hase, commander of the SMS *Derfflinger* and veteran of the Battle of Jutland clarified the importance of eliminating the British maritime superiority as he saw it: “The German people understand now, and as time passes will understand still better, that in the World War there was one objection [objective] for us only which would have given final victory and without which all other victories would have been useless. This was the destruction of the naval superiority of our adversaries. The life or death of the English naval power was the decisive element of the war. If this power was crushed it was a victory for Germany. While this power lasted Germany was reduced to powerlessness in the world. All of our struggle, both on land and sea, finally must resolve itself to the overpowering of the English naval domination.”[20] As long as the British fleet had freedom of movement in the North Sea, Germany was vulnerable.

In his report of the Battle of Jutland, von Hase described German ships that were capable of continuing to fire their guns as they were sinking. It is a testament to Bürkner’s designs that the ship could remain on an even enough keel to provide a usable firing solution. The following narrative, again from Hase’s after action report, highlights these points:

> Shortly after an enormous explosion was heard, like a clap of thunder when a torpedo launched by the *Southampton* struck the *Frauenlob*, which immediately stopped and listed strongly to port. English fire was concentrated on this cruiser,

[19] Ibid., 48.

[20] Georg von Hase, Commander of the *Derfflinger*, Translation G-2 report, no. 12,599-W, 16 August 1927, 2.

> the crew of which gave three cheers for the Kaiser and the Empire, continuing the fire until they sank.
>
> The *Westfalen* [another dreadnought battleship] was hit and although listing to starboard fired on the *Turbulent*, a British torpedo boat, exploding her boilers. The *Turbulent* then disappeared under the waves.
>
> At 3:55 Admiral Hipper announced that the *Derfflinger* and the *Von der Tann* could not fire except with two pieces of heavy caliber, that the *Moltke* had 1000 tons of water in her hold and that the *Seydlitz* was very seriously injured. Whereupon Admiral Scheer gave orders to direct the fleet to reenter Wilhelmshaven.
>
> One of the greatest naval battles of all time had been fought, both fleets were back in their ports. The German fleet knew its strength and waited with assured confidence for new combats. The British had double the numerical strength of the Germans and its losses were double those of the German fleet.[21]

German crews were able to control list and trim because of the enhanced compartmentalization, cross flooding capabilities, and superior damage control training. As long as the ship was near level, the gun crews could fire on the enemy.

In contrast, von Hase saw British ships with little visible damage unable to return fire and subsequently devastated by German gunfire. Sometime after one o’clock in the morning, the Captain of the *Thüringen* saw a large vessel with four funnels. The German searchlights lit it up and they recognized an enemy armored cruiser about 1000 meters away. The *Thüringen* opened fire on the large ship with its intermediate and small artillery. The German shells fell in the direction of the length of the vessel which finally escaped. It was not able to return the fire by even a single gun. It was later learned that this ship was the armored cruiser *Black Prince*, already damaged in the earlier battle, which could not rejoin the British battle fleet due to combat damage. Like a gigantic torch the *Black Prince* met its end, joining the line of sinking vessels before which the

[21] Ibid., 11.

German line passed.[22] Von Hase described the significance of the German ship survivability on the morale of the German sailors and officers. He stated, “In every naval engagement that is fought to a finish, there is the psychological moment when the one side suddenly thinks ‘Good God, the enemy is sinking and we are not, they are on fire and we are not.’”[23]In the end, the British lost fourteen ships and over six thousand men at Jutland and the Germans lost eleven ships and just over twenty-five hundred men.

[22] Ibid., 10.

[23] Ibid., 7.

Table 1. British and German Losses at the Battle of Jutland

Losses	British Grand Fleet	German High Seas Fleet
Battlecruisers	(3) *Indefatigable, Queen Mary, Invincible*	(1) *Lützow*
Pre-Dreadnoughts	(0)	(1) *Pommern*
Armored Cruisers	(3) *Defence, Warrior, Black Prince*	(0)
Light Cruisers	(0)	(4) *Elbing, Frauenlob, Rostock, Wiesbaden*
Destroyers/Torpedo boats	(8) *Ardent, Fortune, Nestor, Nomad, Shark, Sparrowhawk, Tipperary, Turbulent*	(5) *S35, V4, V27, V29, V48*
Personnel-killed	6,097	2,551
Personnel-wounded	674	507
Total	6,945 (includes 177 prisoners)	3,058

Source: Created by author, data from V. E. Tarrant, *Jutland: The German Perspective: A New View of the Great Battle, 31 May 1916* (Annapolis, MD: Naval Institute Press, 1995), 269-272.

German innovation in damage control went beyond ship design and German innovation in damage control went beyond ship design and compartmentalization. After the war when representatives from the U.S. Navy inspected the ex-German battleship *Goeben,* they found that the ship's personnel organization and communications for the control of damage were still intact. Of particular interest was the means available for recording the location, extent, and progress made in the correction of damage throughout the ship. This internal organization had proven its effectiveness onboard *Goeben* when after striking two mines in the Dardanelles, the crew was able to initiate counter flooding within two minutes of the initial blast.[24] A second vital observation from the Navy review was the extent to which German officers and sailors knew their ship. Upon reporting to a German ship, a sailor's priority was to learn how the ship was built and all its compartments and damage control capabilities. This organization remained in place even after the ship had been turned over to the Turkish Navy.

Additionally the German Navy provided its ships with a detailed book of *Damage Control Regulations*.[25] Often containing detailed sketches, these books provided details of major damage control systems as well as flooding and counter-flooding effects for compartments at or below the waterline. Also included was a breakdown of the personnel organization with responsibility for the control of damage. The executive officer directed ship wide damage control efforts.[26] He was assigned a staff that consisted of officers with special training in damage control, sailors from skilled technical rates such as machinists, carpenters, and electricians, and an auxiliary crew of highly trained sailors stationed throughout the ship in critical spaces.[27] This crew was controlled from a central engineering control space and gear and equipment was dispersed throughout the ship to provide rapid response.

The remarkable ability of German warships to sustain damage in battle, return fire on the enemy, and retain their combat power was proof that the Kaiser had realized his goal of building a strong fleet. The new ship designs, the training, and the organization

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[24] United States Navy, *The Stability of Ships and Damage Control*, 7.

[25] Ibid., 2.

[26] Ibid., 8.

[27] Ibid.

for controlling damage became a force multiplier for the German Navy. The ability for ships to sustain heavy damage and still return to port for repairs meant that German sea power was not constrained to the resources required to build new ships; the damaged ships were repaired and returned to sea for less money and in less time than new ships could have been built.

CHAPTER 3

THE U.S. NAVY EXPERIENCE IN THE GREAT WAR

The U.S. Navy's experience in World War I was limited. The Wilson administration enforced a policy of neutrality that made preparations for war difficult and sporadic. Admiral Charles J. Badger, head of the Navy's General Board, testified in front of a Senate Committee that while active preparations for war were difficult given the policy for neutrality, there was advance planning and preparations done where possible. "We had plans, well considered ones. The trouble is that the execution of them did not meet with the approval of the critics."[28] The General Board sought to study the war and apply the lessons of the leading military powers in Europe to its own emerging naval strategy. After the Battle of Jutland it was clear that the Navy had a lot to learn about surviving a war at sea.

There was a striking contrast between the survivability of U.S. Navy ships lost in the war and those of the German Navy during the same period. While only one capital ship was lost to enemy action–a battle cruiser-there were a total of six U.S. Navy surface ships lost during the war. USS *Minnesota* struck a German mine off the coast of Delaware on 29 September 1918. The blast caused serious damage to the ship's starboard side, but she reached port under her own power, with no loss of life. Repairs took five

[28] U.S. Congress, Subcommittee of the Committee on Naval Affairs, Hearings: Naval Investigation, 66th Cong, 2nd sess. (Washington, DC, Government Printing Office), 1098.

months.[29] The destroyer USS *Chauncey* collided with a British steamship and was cut in half on the 20th of November 1917 one hundred and ten miles west of the Straits of Gibraltar. Her crew managed to keep her afloat for just over three hours. Her commanding officer and 20 crew were lost.

Of the few ships lost to enemy action the largest was armored cruiser USS *San Diego* sunk by either a mine or torpedo in the North Atlantic on 19th July 1918 ten miles off Long Island, New York. She capsized and sank in approximately twenty minutes. Fortunately only six of the 1,100 man crew were lost. The destroyer USS *Jacob Jones* was struck by a German torpedo on the Southwestern approaches to Britain on the 6th of December 1917. She sank in eight minutes. Sixty four men were lost.[30]

The essential rallying cry of the Navy during the Great War was the call for a "Navy second to none."[31] Without the experience of sea battles such as Jutland or Dogger Bank, the U.S. Navy had to evaluate the survivability of its ships based on these losses alone. They told a grim story of ships unable to withstand the enemy's weapons and unable to remain afloat long enough even for the crew to get to safety. The American war

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[29] Gordon Smith, "World War 1 at Sea: United States Navy," Naval-History Net, revised 8 March 2011, accessed 6 August 2014, http://www.naval-history.net/WW1NavyUS.htm.

[30] Smith, "World War 1 at Sea."

[31] John T. Kuehn, *Agents of Innovation: The General Board and the Design of the Fleet that Defeated the Japanese Navy* (Annapolis, MD: Naval Institute Press, 2008), 199.

effort was a race for tonnage–produce more tonnage more quickly than the German U-boats could sink it.[32] This was not a strategy for victory. It was a strategy for survival.

Admiral Sims, in stating his motives for writing the letter that led to the Senate investigation of the Secretary of the Navy in the spring of 1920, stated that because of their ultimate success in the war, he feared the Navy failed to realize just how narrowly it escaped defeat at sea.[33] Admiral Sims realized that if the conditions existent in 1917 should be repeated in a future war the Navy and the nation might face a disaster. It was for this reason above all, that the Navy was looking for ways to rebuild itself after the war. In doing so the new leadership was remarkably open minded and sought to learn valuable lessons wherever they were found even if that meant looking to its former advisory for a better way to build strong ships. The U.S. Navy looked at the battle of Jutland for lessons on what modern naval warfare looked like. It based its lessons learned not on its own experience but on what worked for the Germans and on what didn't work for the British.

The most modern ships of the German High Seas Fleet were scuttled at Scapa Flow on 21 June 1919. Consequently, the *Ostfriesland*, an aged *Helgoland*-class battleship and veteran of the Battle of Jutland, was provided to the U.S. Navy to study. The historic sinking of this German dreadnought set the stage for a conflict between the General Board of the Navy and General Billy Mitchell of the U.S. Army Air Service. By this time the General Board, while still advisory in nature, had become the senior policy-

[32] United States War Department, *Economic Mobilization in the United States for the War of 1917* (Washington, DC: War Department, 1918), 17.

[33] Tracy Barrett Kittredge, *Naval Lessons of the Great War* (Garden City, NY: Doubleday, Page and Company, 1921), 102.

making body in the Navy and directed ship and fleet design.[34] Media hype and service rivalry aside, it is clear that the General Board of the Navy saw the tests as an opportunity to evaluate the survivability of German battleships and intended to use what they learned to improve U.S. battleship design.[35] With the advent of airpower, ship designers were required to build ships protected against naval guns, torpedoes and aerial bombardment. The goal was to build ships that were less vulnerable to all manner of attack and improvements in damage control improved overall ship survivability against all threats.

Naval Constructor Commander Alexander Hamilton Van Keuren, USN from the Bureau of Construction and Repair inspected *Ostfriesland* prior to its transit from Europe, upon reaching the test sight off the Virginia Capes, and multiple times between bombing runs. His assessment of the ship spoke to its age and neglect. Watertight doors and hatches were too damaged to close. Manholes were left open and there was evidence a water leaking in from the sea. In Van Keuren's view, the *Ostfriesland* was already sinking before the first bomb was dropped. In spite of her questionable seaworthiness, and the lack of any damage control action, she withstood two days of bombing. Van Keuren believed that the test indicated that had there been a crew on board to take corrective action, the ship might have survived the bombing.[36] Instead, she flooded and sank off Cape Hatteras on 21 July 1921. Dr. John T. Kuehn suggests that it was Van

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[34] John T. Kuehn, "*Ostfriesland*, the General Board of the Navy, and the Washington Naval Treaty," in *New Interpretation in Naval History: Selected Papers from the Sixteenth Naval History Symposium Held at the United States Naval Academy 10-11 September 2009*, ed. Craig C. Felker and Marcus O. Jones (Newport, RI: Naval War College Press, 2012), 74.

[35] Ibid., 77.

[36] Ibid., 80.

Keuren's final report on this matter that influenced the language of the reconstruction clause in the Washington Naval Treaty and opened the door to improve the survivability of battleships the Navy retained after the treaty was signed.[37]

On 14 November 1921 a German article appeared in a report from the office of Naval Intelligence that eventually came to the attention of the Bureau of Construction and Repair. The article was an account of the Battle of Jutland written by Otto Looks, former chief engineer of the *Seydlitz*. In a letter to the Director of Naval Intelligence dated 30 March, 1922, the acting Chief of the Bureau of Construction and Repair requested additional information on the damage control measures aboard the *Seydlitz* or any other former German battleships. The Chief of Bureau specifically requested information on the number and location of valves, the arrangement of operating gears and the means for controlling dewatering and cross flooding capabilities of the ship.[38] In addition, he asks for details about the visual aids and communication systems in the central control station as described in Looks' article.[39]

A version of Otto Looks' article appeared in the Royal Navy's professional journal *The Naval Review* in May 1922. In it the late chief engineer recounted how the training, the shipboard organization, and the design of the ship itself all combined to help the *Seydlitz* and her crew return to port in spite of the tremendous damage she suffered at

[37] Ibid., 82.

[38] L. McNamee, Memorandum on the Subject of Damage Control on German Ship *Seydlitz*: 31 March, 1922 (National Archives and Record Administration, Record Group 38,Washington, DC).

[39] Bureau of Construction and Repair, Memorandum on the Subject of Damage Control on German Ship *Seydlitz*: 30 March, 1922 (National Archives and Record Administration, Record Group 38, Washington, DC).

Jutland. He wrote of countless drills, a vast array of watertight doors and hatches, and a dedicated communication system that allowed reports from all over the ship to be routed to the central control station.[40] The ship's damage control teams were split into fire parties, repair parties, and leak stoppers. Every team focused on the damage or equipment casualties for which they had trained.

In response to the Bureau of Construction and Repair's request for additional information regarding the equipment, organization, and design of the German damage control system, W. P. Beehler, the Naval attaché in Berlin, sent a two volume copy of the German *Damage Control Regulations* from one of the Imperial Navy's remaining ships, the SMS *Braunschweig*. Beehler also indicated that he could help find answers to any follow on questions the Bureau might have about the material. The two volumes were sent to the Bureau untranslated so as to prevent any delay.[41] This indicates that there was a sense of urgency in the Bureau's request to acquire more detailed information regarding the German damage control system.

The availability and detail of these two volumes and the soundness of the principles they contained resulted in an increased interest in the subject of damage control throughout the Navy. Definite arrangements providing for damage control features in the organization of new and existing ships began immediately. Warships slated to be disposed of (sunk) in accordance with the Washington Naval Treaty were

[40] Otto Looks, "The Engine Room Staff in the Battle of Skagerrack," *The Naval Review* 10, no. 2 (May 1922): 307-317.

[41] W. P. Beehler, Memorandum on German Damage Control, 10 May 1922 (National Archives and Records Administration, Office of Naval Intelligence, Confidential "Suspect" and General Correspondence File, 1913-24).

often altered with proposed conversion designs in mind in order to test the survivability of the new design.[42]

The Navy's resolve to strengthen the battleship took two developmental paths. First was the incorporation of new damage control features in ships' organization and design. Second came drills and the development of damage control books and charts by the Bureau of Construction and Repair similar to those received for *Braunschweig*. Translated copies of the German *Damage Control Regulations* were furnished to all capital ships in the fleet, together with newly created damage control diagrams of the battleship USS *New Mexico* to illustrate the application of the German system to U.S. ships. An investigative board was appointed within the Battle Fleet in 1924 to further study the subject of damage control and recommend a system to be implemented in the battleships. The board made recommendations to the Commander in Chief of the Battle Fleet and that report was transmitted to the Chief of Naval Operations for review. At nearly the same time a second board, the Ship Control Board, published a report on its findings after a thorough review of changes in shipboard organization to better suit an improved system of damage control on board all naval vessels. Recommendations from the Ship Control Board included the formation of repair parties with their stations dispersed throughout the ship.[43] This was remarkably similar to the organization described in detail in the Otto Looks article.

The recommendations of the 1924 report by the Ship Control Board were adopted by the Chief of Naval Operations and those made by the Battle Fleet were left as optional

[42] United States Navy, *The Stability of Ships and Damage Control*, 59-61.

[43] Ibid., 107.

for the commanding officers.[44] Within the Battle Fleet's final report was a recognition that while the greatest protection from war time battle damage is gained through extensive watertight compartmentalization and armor, such measures must be supplemented by quick and effective action by the crew to effect firefighting, flooding control, and repairs to essential services. It also recognized that one of the most crucial tasks of the crew must be to prevent to the spread of such casualties such as progressive flooding. It was clear that the crew must be well trained in damage control in order to safeguard the ability of the ship to fight.[45]

The Battle Fleet board on damage control stated that in times of peace organization and training for the control of damage should receive attention equal in thoroughness to any of the other battle activities aboard ship. The steps outlined in this report and eventually adopted by the Chief of Naval Operations for an efficient damage control organization prior to going into battle are as follows: Place the ship in the most favorable condition with regard to draft, trim, and distribution of liquid load; close all watertight fittings (doors, hatches, and scuttles) above and below the waterline not essential for the conduct of warfighting; Establish roving patrols capable of communicating with a central control station to rapidly investigate for, locate, and initiate immediate action to correct damage; and finally, station personnel and equipment detailed for the repair of damage throughout the ship in locations providing most effective access to critical areas and equipment.[46]

[44] Ibid., 113.

[45] Ibid., 112.

[46] Ibid., 108.

The report goes on to describe the actions to be taken once damage has occurred. Again, the actions listed follow largely the corresponding procedure in the German manuals:

1. Close all watertight fittings not already closed in the damaged compartment and all adjoining compartments.
2. Report the location of the damage and the extent of any fire or flooding to the central control station.
3. In case of flooding, isolate the leaking portion of the vessel. Use plugs and patches to minimize additional leaks and apply shoring where structural weakness may occur.
4. Active dewatering can be accomplished by pumping out the adjacent compartments.
5. Begin the repair of damaged communications lines, telephones, piping, and electrical grounds and shorts.
6. Consider counter-flooding as a means to reduce list; and finally
7. Dewater the affected compartment with efforts toward repairing the leak.[47]

These steps to control damage apply in both war time and in peace.

The report of the board went into some detail regarding the need for permanent organizational changes. Believing that damage control functions could be accomplished more rapidly and more efficiently, the board recommended assigning a single responsible officer, thoroughly trained in damage control measures, whose orders should be carried out by sailors assigned to him. These sailors should be required to know their ship inside and out and be responsible for the daily maintenance and upkeep of the ship's damage control equipment. The repair lockers should be supplemented by sailors from various rates with non-critical watch standing responsibilities so that in case of damage they could leave their stations to assist in damage control efforts. Finally, when required, that

[47] Ibid., 109.

portion of the crew not actively engaged in fighting the enemy must be subordinate to the direction of the damage control officer.[48]

In general, the recommendations of the board as to the procedures to be followed when experiencing flooding were nearly identical to the corresponding guidance in the German *Damage Control Regulations*. The board rendered as a guideline that pumping and sluicing, the use of air-ejection systems, the transfer of oil or water and counter-flooding should only be carried out on orders from the damage control officer after he has a full understanding of the extent and impact of doing so. The board cautioned that counter-flooding should not be attempted except in an emergency when no other option is available to restore the ship to an efficient fighting condition.[49]

Definite recommendations were made as to the organization of the damage control division including a description of the officer personnel and the numbers and training of the crew assigned to the various subdivisions. With regard to the authority of the damage control officer, the board recommended that in carrying out the work of the damage control division he have full authority and assume all responsibility with the proviso that the operations mentioned above including counter-flooding, be carried out only with the authorization of the commanding officer, and that the damage control officer keep the commanding officer fully aware of the conditions affecting the fighting ability of the ship. Likewise, he was to keep the ship control officer and the engineering

[48] Ibid., 110.

[49] Ibid., 111.

officer apprised of any conditions that might affect functions of the ship under their respective control.[50]

The board listed a number of items concerning what information should be compiled into the so called damage control book. This information included the best conditions for entering action, general data on buoyancy and stability characteristics of the ship, and the preparation of dewatering and counter-flooding diagrams. Again, this was all in keeping with the German system. Minor changes were made to the style and detail of the damage control diagrams prepared by the Bureau of Construction and Repair for *New Mexico*. It was recommended that every deck be displayed on its own diagram. The German model had combined the compartments below the third deck onto a single diagram.[51]

The board also recommended that drills be conducted by the damage control division for the purpose of developing a thorough knowledge of the location of all compartments, means of access, location of vital equipment, methods of damage control and repairs, and use of specialized equipment. Developing skills to search for and detect damage was also critical to damage control training. Finally, drills to help sailors develop familiarity with communication equipment and reporting procedures was also recommended. Varying the conditions under which these drills were conducted helped prepare the crew to face the unpredictable nature of real casualties at sea.[52]

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[50] Ibid.

[51] Ibid., 120.

[52] Thomas J. Kelly, *Damage Control* (New York, NY: D. Van Nostrand Company, 1944), 23-28.

By the time this report reached the Chief of Naval Operations, he had already settled on the recommendations of the Ship Control Board. Recall that the Ship Control Board made recommendations vis-à-vis damage control in 1942. These recommendations included among other items detailed provisions for the organization and stationing or repair parties. Many of the Battle Fleet recommendations mentioned above were not immediately adopted. Perhaps the most significant measure that was not initially adopted was the creation of a damage control division headed by an officer specifically trained for and charged with the control of damage. Instead, the first lieutenant, who was designated as the casualty officer in the Ship Control Board's report was tasked with the collateral duties for damage control coordination.[53] The detailed recommendations and procedures for forming repair parties which closely modeled the German regulations were carried out by each ship by way of drills and reorganization. The subdivision of the repair parties into forward, amidships, and after repair parties also came from the Ship Control Board's recommendations.[54]

In addition to examining the tactics, techniques, and organization that worked for the German Navy, the U.S. Navy also examined what went wrong for the British. It was the British discovery of which building materials proved unsuitable for combat vessels that influenced the U.S. Navy the most. By combining the successes of the German fleet and the failures of the British, the U.S. Navy was able to takes the lessons learned from both sides of the war and use them to create a significantly more capable, more survivable fleet of its own.

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[53] United States Navy, *The Stability of Ships and Damage Control*, 112.

[54] Ibid., 113.

In April 1928, Captain Robert Henderson, USN wrote a letter to the Secretary of the Navy and the Chief of Naval Operations urging them to take another look at the lessons of the Battle of Jutland. Henderson referenced a confidential account of the battle written by the executive officer of HMS *Warspite*, a *Queen Elizabeth* class battleship that participated in the battle. Henderson believed that by careful study and the investment of a reasonable amount of money, it was possible to save a ship during battle that might otherwise become ineffective or lost. Henderson listed some of the experiences of the British ship and her crew, and provided his recommendations as to needed improvements aboard U.S. Navy ships, including the need for a dedicated officer and assistants tasked with damage control as their primary duties.[55]

Henderson called attention to the many personnel casualties that resulted from poor choices of materials within the ship. For instance, in some cases sailors were prevented from getting near the fire and effectively combating it on account of molten lead dripping from overhead wires. Thick smoke choked sailors as the linoleum used to cover the decks burned or smoldered. Broken glass was also a problem, requiring sailors to wear heavy leather gloves and boots to prevent injury.[56] Henderson called for material substitutions where possible, and where no other materials were available, consideration should be given to placement of the materials so as to not impede sailors from taking action to address damage in critical compartments. In the case of the many heavy steel

[55] Robert Henderson, Memorandum on Neglected Developments in Warship Equipment Suggested by Experience in the Battle of Jutland, 15 April, 1928 (National Archives and Records Administration, Record Group 38, Office of the Chief of Naval Operations: Division of Naval Intelligence, General Correspondence 1929-1942), 1.

[56] Ibid., 3.

splinters reported in *Warspite* as a result of shelling, Henderson recommended that the Navy develop a structural steel that had more toughness to prevent such splintering or to adopt splinter nets to prevent widespread distribution of the metal shards.[57]

Other concerns addressed in his letter were the need for specialized equipment onboard U.S. Navy ships. *Warspite's* executive officer praised the use of portable, submersible electrical pumps for dewatering spaces; Henderson recommended equipping U.S. ships with some version of these pumps. Henderson also recommended improvements to the fire main, including more isolation valves and additional plugging and patching kits to make emergent repairs when needed. He also discussed the need for additional escape and access hatches from critical compartments below the waterline.[58]

Like the Battle Fleet board on damage control, however, Henderson called for significant changes to the personnel organization. His first recommendation was that U.S. Navy ships be provided with an officer and assistants whose primary duties were to keep the ship on an even keel, holding drills for training the crew on flooding response and righting the ship. Several of the hits suffered by *Warspite* were never investigated and the damage never found. Henderson echoed the board's suggestion to form roving parties trained to find and report damage throughout the ship.[59]

A new system for damage control was emerging and the tactics and techniques were formalized in manuals such as the Bureau of Construction and Repair's "General Specifications for Building Vessels of the United States Navy". The 1917 version was

[57] Ibid., 4.

[58] Ibid., 3.

[59] Ibid., 2.

updated in 1929 to reflect lessons from the war. Included in the new edition was a detailed repair locker inventory and organization, new regulations regarding what materials could be used in the construction of warships, and detailed diagrams for watertight compartmentalization.[60] These new regulations continued to be revised, improved, and implemented throughout the interwar period but they never strayed far from the original German *Damage Control Regulations*. In many cases they were updated to more closely follow the German model.

An important step in institutionalizing the German practice of preparing damage control books for each ship can be seen in an insert prepared to supersede portions of the 1936 *General Specifications*. *Appendix 15: Instructions for Preparing Damage Control Books for Vessels of the United States Navy* galvanized the importance of gathering critical damage control related specification. By 1936, the Navy mandated that the contractor responsible for building the ship should be responsible for preparing, printing and furnishing the Damage Control Book to the crew.[61] The appendix describes what information must be included, what system diagrams are to be made available in the central control stations, and the formats for various damage control data to be included in the Damage Control Book.

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[60] United States Navy Department, Bureau of Construction and Repair, *General Specifications for Building Vessel of the United States Navy* (Washington, DC: Government Printing Office, 1929), 298.

[61] United States Navy Department, Bureau of Construction and Repair, *General Specifications-Appendix 15: Instructions for Preparing Damage Control Books for Vessels of the United States Navy* (Washington, DC: Government Printing Office, 1936), 1.

Also included are a collection of standard symbols used in damage control diagrams, and a color chart for damage control diagrams. The Bureau of Construction and Repair directed that the system diagrams be large enough to be useful in tracking and locating damage going so far as directing the manner in which they were to be folded into the book. The diagrams were to be creased in such a way as to allow the user to open to the section that was needed without having to open the entire diagram.[62] Other notable requirements include listing the identifying numbers of doors, hatches and cutout and isolation valve.

During the interwar period, the U.S. Navy continued to improve the survivability of its ship, improve the training of its sailors, and made damage control the duty of every man aboard ship. Interior communication technology continued to improve. Firefighting tactics continued to evolve. New ships were built with increased compartmentalization both below and above the waterline. Additional protection measures were added to mitigate the damage of near misses and torpedo and mine detonations. Vital systems such as firemain, main drainage, and vital air systems were built with more isolation valves so that damaged portions could be secured while still operating the rest of the system. Fire plugs were provided in number and location so that any point on a capital ship could be reached with a hundred-foot hose from each of two fire plugs.[63] The U.S. Navy was finally building resilient ships, and these ships proved their worth as another world war approached.

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[62] Ibid., 10-11.

[63] United States Navy Department, *General Specifications for Building Vessel of the United States Navy*, 184.

CHAPTER 4

INTERWAR INNOVATION AND IMPROVEMENT

On 7 December 1941 Japanese bombs and torpedoes sunk or severely damaged twenty-one U.S. Navy ships in Pearl Harbor, Hawaii. Of those, all but three, battleships USS *Arizona*, USS *Oklahoma*, and auxiliary ship USS *Utah*, were refloated, repaired and returned to the war effort by 1944.[64] This remarkable feat was only possible because of the innovations and improvements in ship survivability made during the interwar period. USS *West Virginia* was the most severely damaged of the salvaged ships. As many as nine Japanese torpedoes struck the ship in addition to multiple hits from dive bombers. Quick thinking by LCDR J. S. Harper, first lieutenant, and the capability to counter flood the ship's main compartments allowed *West Virginia* to settle in the mud on an even keel, making her salvage possible. The ability to withstand such damage was in stark contrast to our ships lost in World War I; *West Virginia* underwent extensive modernization and rejoin the Pacific Fleet in July 1944.[65]

The Navy made tremendous progress in building strong, survivable ships and training their crews to combat damage and keep the ship in the fight. The evolution of damage control in the Navy's collective consciousness during the interwar period is apparent in the consecutive editions of a particular United States Naval Academy

[64] Pearl Harbor.org, "Ship and Aircraft Sunk or Survived in the Attack on Pearl Harbor," accessed 6 November 2014, http://www.pearlharbor.org/ships-and-aircraft.asp.

[65] Naval History and Heritage Command, "Pearl Harbor Raid, 7 December 1941: Salvage and Repair of USS *West Virginia*, December 1941–April 1943," accessed 6 November 2014, http://www.history.navy.mil/photos/events/wwii-pac/pearlhbr/ph-wv9.htm.

textbook originally titled *Principles of Naval Architecture and Warship Construction*. In the preface to the first edition published in 1924, there is no mention of damage control, watertight integrity, or the notion of survivability. In the preface for the 1928 edition, the authors mention modernization and changes to older battleships and state that the book's discussion of watertight subdivision is expanded into a separate chapter due to growing interest in the subject. The reader finds the first mention of the term 'damage control' in the preface to the 1930 third edition where a brief description of damage control is added to the chapter on the importance of watertight subdivision. Finally in 1935, ten years after the book was first published, the authors' preface begins by defining damage control: "the operation of a warship so as to preserve her fighting efficiency when the hull has been damaged by enemy attack." The topic has, by this time, assumed such a dominant role in the field of ship construction and training that the text book was retitled *Principles of Warship Construction and Damage Control* with significant portions of the book dedicated to the training, techniques, and organization of shipboard damage control.[66]

Another seminal text is the enlisted sailor training manual for the U.S. Navy entitled *The Bluejackets' Manual*. First published in 1902, the book is used to teach new sailors about the basics of Navy life and is a helpful reference providing information about a wide range of Navy topics. The 1917 edition contains the very basics of the pre World War damage control system. Under the section "General Characteristics of the Ships" The question "What is a watertight compartment?" appears. The answer is given as follows:

[66] G. C. Manning and T. L. Schumacher, *Principles of Warship Construction and Damage Control* (Annapolis, MD: United States Naval Institute, 1935), v-xi.

> All steel ships are divided into a large number of rooms and passageds that are so fitted as to be watertight. Each separate compartment is known as a watertight compartment. The compartments serve to keep the ship afloat by confining the water if her hull is pierced.[67]

This definition illustrates that the building blocks of modern damage control were in place years before the U.S. entered the war. A brief description of the drainage system and this portion of the answer given to the question "How is watertightness secured in a ship" point to a basic understanding of the concept that will be transformed during the interwar period.

> *It is most important that all appliances for securing watertightness be kept in an efficient condition*. If not, when the emergency comes, the various watertight compartments that have been relied on to keep the ship afloat in just such an emergency will prove that they are not watertight, and we shall find that we have deceived ourselves into false security.[68]

Descriptions of leakstoppers, fire quarters, and the basics of firefighting[69] are mentioned in this early edition. Individual components of damage control are clearly in place. However, this is not the comprehensive system that is found on board German ships.

While the building blocks of damage control appear earlier in *The Bluejacket's Manual* than in *Principles of Warship Construction and Damage Control*, the innovations of the interwar period do not begin to appear in the enlisted reference manual until 1950. In addition to similar descriptions of watertight compartments, and critical system

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[67] United States Navy, *The Bluejacket's Manual* (Annapolis, MD: United States Naval Institute, 1917), 120.

[68] Ibid., 129.

[69] Ibid.,168.

descriptions, the 1950 edition also has dedicated subsections on damage control and firefighting.[70]

In the late 1920s the concept of "ship control" was a catch all that encompassed everything that could not be regarded as fire control[71] (the firing of ordnance). Directives were passed to commands from either the Fire Control Board or the Ship Control Board. However, as the Navy's collective thinking about survivability matured, ship control developed into two important and distinct functions; maneuvering control and damage control. The navigator was considered the maneuvering officer and, depending on the size of the ship, either the executive officer or, for a short period of time, the first lieutenant was assigned the collateral duty as the damage control officer. Even large Navy dirigibles were to have an officer designated for damage control coordination. This new organization was officially sanctioned in the 1930 edition of the *Manual of Interior Control*.[72] The new manual defined damage control as a phase of ship control and divided it into five subspecialties: stability control, gas defense, firefighting, repairs, and care of the wounded. Coordination of damage control efforts were to be exercised from the central station. Officers assigned to repair stations forward, amidships, and aft and on the upper deck (depending on the size of the ship) acted as assistants to the damage control officer. The damage control officer exercised control over a dedicated telephone circuit designated 2JZ (casualty repair) and other parallel circuits as could be made

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[70] United States Navy, *The Bluejackets' Manual* (Annapolis, MD: United States Naval Institute, 1950), 525.

[71] Robert B. Carney, LCDR, USN, "Damage Control," *U.S. Naval Institute Proceedings* 329, no. 56 (July 1930): 623.

[72] Ibid., 624.

available.[73] The repair station officers reported to the damage control officer, and the damage control officer reported directly to the commanding officer and coordinated efforts with the battery-control officer and engineer officer as necessary when damage control efforts impacted gunnery or propulsion.

In a 1936 article in *U.S. Naval Institute Proceedings*, Ensign Edward J. Fahy, USN made the argument for a new rating in the Navy; that of Damage Controlman (DC). Ensign Fahy observed that sailors given the task of damage control were “a motley assortment of ship fitters, carpenter’s mates, electricians, various engineering ratings, and whatever other ratings might be included in the repair parties.”[74] When the damage was outside the specialty that these sailors were trained in, they lacked the expertise to make suitable repairs. Fahy argued that there should be a specialized rating for damage control, and that training for this rating should include all aspects of casualty control, repair, and maintenance of damage control related equipment. Finally, he proposed establishment of a school for the study of damage control with a real ship or ship-like environment to provide first hand, realistic training. During the interwar period, all three of these innovations and organizational changes came to pass.[75]

The billet of damage control officer was created in the late 1920s and by 1930 had been combined with the duties of the first lieutenant on ships larger than destroyers.[76]

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[73] Ibid., 623.

[74] Edward J. Fahy, ENS, USN, “Lo! The ‘Poor Janitor’ Thinks,” *U.S. Naval Institute Proceedings* 395, no. 62 (January 1936): 31.

[75] Ibid., 32.

[76] Clinton J. Heath, LCDR, USN, “The First Lieutenant: A liability to the Ship,” *U.S. Naval Institute Proceedings* 500, no. 70 (October 1944): 1235.

The damage control officer was tasked as the assistant to the executive officer in "coordinating all departments in the ship's organization for damage control, assembling correct information concerning the placing of the ship in material condition for battle and supervising exercises and training in damage control and gas defense."[77] Throughout the years preceding the Second World War it became clear to some that the first lieutenant was not the right position to exercise the broad ranging duties of a damage control officer. Because the engineering department was, and continues to be, the most directly connected with the material, systems, and sailors for which the damage control officer is responsible, it made sense that the damage control officer needed to be tied to the engineering department. After the war the role and responsibility of the damage control officer fell either on the executive officer or the engineer officer, and the role previously held by the first lieutenant was renamed damage control assistant, working directly for the damage control officer.[78]

Alterations authorized by the Bureau of Construction and Repair and later by the Bureau of Ships sought to improve the fighting power of U.S. ships. Many of the improvements were intended to increase watertight subdivision and watertight integrity in older ships. The use of welded patches to blank off all doors, hatches, manholes, and other access openings not considered absolutely necessary became common. Installing additional watertight bulkheads provided better internal subdivision. New ventilation valves and ducting helped to combat the spread of fire and smoke through the ventilation systems. Alterations as basic as raising overboard discharges and scuppers to at least a

[77] Ibid., 1239.

[78] Ibid., 1240.

deck height above the waterline helped to combat the potential for flooding. Sailors were trained to constantly check compartments and fittings for watertight integrity; a ship with poor or damaged watertight fittings was susceptible to progressive flooding. Organizational changes such as material inspections and watertight tests accompanied the new focus on watertight integrity.[79]

Nearly all of the ships sunk or damaged at Pearl Harbor were equipped with a damage control station very much like that described by Otto Looks in *Seydlitz*. The damage control station became the nerve center and primary battle station for the damage control organization. Dedicated communications from all repair stations, the bridge, central control stations, and other critical watch standing positions were directed through the damage control station. These stations were formerly outfitted with the equipment and communications necessary to perform the functions of a secondary ship control station. However, as the focus on damage control increased, these installations were removed to allow for a dedicated control station for the damage control officer. By the end of the interwar period damage control stations contained casualty boards, communication equipment including sound powered telephones that operated without electricity, tables or desks to lay out ships' plans, fire-alarm indicator boards, and list and trim indicators.

The casualty boards provided compartment access and ship subdivision plans drawn to a scale of one-eighth of an inch equals one foot.[80] These plans, modeled on

[79] Thomas J. Kelly, *Damage Control* (New York, NY: D. Van Nostrand Company, 1944), 59.

[80] Ibid., 71.

those originally seen onboard the German battlecruiser *Goeben*, showed the watertight, oil tight, and fume tight boundaries necessary for isolating fire, smoke, or flooding. The compartment and fitting descriptive number was also displayed. Accesses to each compartment such as hatches, scuttles, and doors were also indicated and numbered. The casualty boards were of a large enough scale to allow the damage control officer to record pertinent information for a given casualty such as lists of repair party personnel assigned to combat the casualty, times and critical events pertaining to the casualty, and status of repair and coordination. The boards were laminated in plastic and a china marker was used so that information concerning the casualty could be easily erased once it was no longer needed. The marked board provided a complete picture of the casualty in a single glance, with the extent of the affected area delineated longitudinally and vertically.[81] Eventually, diagrams of critical piping and electrical systems were added to the casualty boards to assist the damage control officer in isolating damaged systems. All of this was executed in a manner very similar to that described by Otto Looks.[82]

Additional innovations and advancements in damage control during the interwar period included the introduction of the all-purpose firefighting nozzle. The three way handle or "bail" had three positions. With the bail all the way forward the water was shut off; in the middle position the nozzle produced a high velocity water fog that was useful for cooling overheated compartments and combating fires. With the bail pulled back in the third position, the water formed a solid stream that was used to breakup burning

[81] Ibid., 72.

[82] Looks, "The Engine Room Staff in the Battle of Skagerrack," 313.

material such as paper or cloth.[83] Chemical and mechanical foam generators were used as both portable and installed firefighting equipment. Sailors had to be trained to operate and maintain these sometimes complicated systems.[84]

Even more dramatic than the raising of battleships from the mud of Pearl Harbor is the remarkable role that these advances in damage control played in turning the tide of war in the Pacific. Just prior to the Battle of Midway, USS *Yorktown* was heavily damaged in the Battle of the Coral Sea on 8 May 1942. Near misses from Japanese dive bombers opened seams in her hull and ruptured diesel fuel tanks. More seriously, an 800-pound bomb crashed through her flight deck amidships, penetrated five decks down into the ship, and exploded just above the main engine room. The blast killed or seriously wounded sixty-six officers and sailors, demolished several compartments, started fires on multiple levels, and disabled much of the electrical distribution system throughout the ship. Repair parties were able to put out the fires quickly and *Yorktown* was able to continue the fight, including launching and recovering aircraft.[85] The damage was so severe that Admiral Aubrey Fitch, USN, Commander, Task Group 17.5 that included *Yorktown* and *Lexington*, estimated it was going to take ninety days to conduct the necessary repairs. Back in Pearl Harbor, the shipyard workers returned the ship to service in only seventy-two hours. Their job was possible only because of the improved survivability built into U.S. Navy ships and the ingrained damage control training of her

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[83] Kelly, *Damage Control*, 93.

[84] Ibid., 97.

[85] Samuel Eliot Morison, *Coral Sea, Midway and Submarine Actions: May 1942–August 1942* (Edison, NJ: Castle Books, 2001), 55-57.

crew that allowed the damage control parties to contain the damage and make substantial repairs to critical structures and systems during the nineteen day return trip from the Coral Sea.

Yorktown was hit by at least three torpedoes and multiple bombs before she eventually capsized and sunk after the Battle of Midway. Even though the dive bomber attack that initially disabled the carrier on 4 June ignited fully fueled and armed planes on her deck, installed CO2 flooding and hangar sprinkler systems prevented the devastating explosions seen on the Japanese carriers caught in a similar state.[86] These sprinkler systems and the arrangement of their control valves were first accounted for in the 1929 edition and reprinted in the 1940 edition of the *General Specifications for Building Vessels of the United States Navy*.[87] The crew of Yorktown fought flooding and fires for three days before she finally sunk on 7 June. In contrast to U.S. carriers that had increased the isolation capability of essential damage control systems such as firemain and main drainage, Japanese fire main systems on its fleet carriers were simply divided into port and startboard loops. This basic arrangement meant that a single hit could disable half of the ships water supply.[88] This inability to isolate damaged portions of critical systems and the fact that they were ill prepared to absorb damage and continue functioning led directly to the inability of the crews to contain the fires and ward off the

[86] Jonathan Parshall and Anthony Tully, *Shattered Sword: The Untold Story of the Battle of Midway* (Washington, DC: Potomac Books, 2005), 297.

[87]United States Navy Department, Bureau of Construction and Repair. *General Specifications for Building Vessel of the United States Navy* (Washington, DC: Government Printing Office, 1940), U-12-1.

[88] Parshall and Tully, *Shattered Sword*, 246.

continuing attacks that led to the loss of four Japanese carriers during the Battle of Midway.[89]

Without the damage control innovations of the previous years, *Yorktown* may not have been available to participate in the battle of Midway and without her dive-bombers and torpedo planes the result of the battle might well have been different. It is worth noting here that Lieutenant Milton E. Ricketts, USN the officer in charge of the engineering repair party in *Yorktown* at Coral Sea, was posthumously awarded the Congressional Medal of Honor for his heroic role containing the fires that ultimately took his life after the battle.[90]

The innovation in shipboard damage control between the First and Second World Wars made success in the Pacific theater possible. The U.S. Navy could not have survived a race for tonnage in the Pacific. The distances and the dangers were simply too great. The Navy changed the way it designed and built its ships. It changed the way it trained and organized its crews. The Navy changed the way it fought fires and flooding at sea and that increased the combat effectiveness of its ships. These stronger, more survivable platforms held the line in the Pacific until the forces already engaged in Europe could be brought to bear.

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[89] Ibid., 248.

[90] Congressional Medal of Honor Society, "Ricketts, Milton Ernest," accessed 6 November 2014, http://www.cmohs.org/recipient-detail/2964/ricketts-milton-ernest.php.

CHAPTER 5

CONCLUSION: RMA AND LEARNING FROM THE ENEMY

In *The Dynamics of Military Revolution: 1300-2050*, Williamson Murray and Macgregor Knox state that a revolution in military affairs (RMA) requires the assembly of a “complex mix of tactical, organizational, doctrinal, and technological innovations in order to implement a new conceptual approach to warfare or to a specialized sub-branch of warfare.”[91]

The U.S. Navy’s interwar innovation in damage control combined new technology, new tactics, and significant shipboard organizational change to create a highly efficient and effective method of sustaining combat power at sea. The new adaptation of the German damage control doctrine gave ship survivability new precedence and constituted a revolution in military affairs. The tactics of shipboard damage control consist of both command and control and the use of advanced equipment and techniques to combat fire and flooding. This thesis described how the combination of new firefighting and flooding control tactics significantly increased the ability of sailors to control damage during combat as evidenced by the discussion of the performance of U.S. warships in the Second World War. New techniques for compartmentalization, liquid loading, electrical power distribution, interior communication, ventilation and fire protection all lent themselves to increasing the ship’s resistance to damage. Organizational innovations in training, distribution of manpower, and command structure also contributed to the overall effectiveness of the new damage control methods.

[91] Macgregor Knox and Williamson Murray, *The Dynamics of Military Revolution: 1300-2050* (New York: Cambridge University Press, 2001), 12.

By 1944, the U.S. Navy was training both officers and sailors that damage control was vital to their survival at sea. It was no longer the responsibility of someone else, it was every man's duty to train, learn, and perform damage control.[92] U.S. Navy damage control doctrine was completely rewritten to all but mirror the German model. Existing technology in the United States was used to increase the effectiveness of shipboard damage control, but applied using new methods and implemented on a much broader scale than ever before. These improvements were made to augment the new technology in naval weaponry and armor. No matter how big the guns or how thick the armor plating was, ships at war suffered damage. Technological innovation in control and repair of that damage took up where technological advancement in armament left off. It is clear that the combination of tactics, organizational change, doctrine, and technology combined to create a significant and lasting change in the U.S. Navy's methods of operations in peace and in combat.

Learning from the Enemy

The Greek poet and playwright Aristophanes stated that men of sense often learn from their enemies. Nowhere is this statement truer than in war. Military organizations that fail to learn the lessons taught by their adversaries miss a tremendous opportunity. In order to learn from anyone one must first acknowledge that there is a gap in their own skill set. This can be especially difficult when it comes to learning from an enemy because there must be respect in order to acknowledge that the enemy has something worth teaching. The United States military has learned from the British, the Germans, and

[92] Kelly, *Damage Control*, 1.

the Russians-Soviet Union. As long as the United States maintains respect for the enemies it faces, she remains capable of learning from them. In today's complex environment it is more important than even that the U.S. military keep this in mind.

The U.S. Navy is no exception. It has a long and distinguished history of recognizing and adapting new ideas from wherever it finds them. After the First World War the Bureau of Construction and Repair published its opinion that, "it can not be questioned that the Germans were right and rational in treating the control of damage as they did, considering the maintenance of a ship afloat and in fighting condition of importance, paramount to her ability to strike at the enemy. The experience and results attained during the World War are a lesson we can not afford to ignore."[93] It is not remarkable that a military service in time of war can look at the enemy and see an opportunity to improve itself by mirroring the enemy's actions. It is remarkable, however, that in the case of damage control the changes were implemented in such a way as to survive nearly a century largely unchanged from their original form.

Along the way there were areas of research that deserved more time and attention than allowed in this thesis. There is very little information on damage control in the predreadnought era. The shifts from sail to steam, wooden hulls to steel, and even from coal to diesel oil, must have caused dramatic shifts in damage control organization onboard warships. Archival research in this area would provide a clearer picture of what system the U.S. Navy had in place before the First World War. Additionally, research into the development of the German system of damage control would certainly prove interesting and enlightening. Their story is almost certainly one of evolution and not

[93] United States Navy, *The Stability of Ships and Damage Control*, 8.

revolution. How did they get it right? A more technical examination of the innovations in hull materials for both armor and general ship building would provide additional details to an aspect of ship survivability that developed significantly during the interwar period. Finally, a close look at the manning of ships and a comparison of the number of sailors required to combat shipboard damage would help illustrate the need for robust crews in order to adequately respond to damage control emergencies.

Implications for Today

So what? Why is studying the origins of shipboard damage control important in 2014? Here is why. The United States is no longer guaranteed unobstructed access to all parts of the globe. There exist both state and non-state actors that possess the capability to delay or deny the U.S. Navy access to critical seas and waterways. Anti-access/area denial, or A2AD, weapons such as sea mines and anti-ship missiles are the most significant threat facing the U.S. Navy today.[94] While the U.S. Navy has the most powerful blue-water force in the world, it is poorly prepared to operate in restricted or contested water space. One only has to look at the state of the outdated minesweeping platforms to determine that critical A2AD capabilities such as mine warfare have not been a priority for the U.S. Navy. Similarly, advanced antiship missiles are on the market for which the Navy has little to no answer. Large swaths of the South and East China Sea are under a protective blanket of antiship missile defense systems. At a time when the Navy's attention is being refocused in the Pacific, attacks such as those against the *Cole*, *Stark*, and *Samuel B. Roberts* are likely to recur if the Navy has to access mined or

[94] See for example, John T. Kuehn, "Air-sea Battle and its Discontents," *United States Naval Institute Proceedings* (October 2013): 42-47.

protected water space. Effective shipboard damage control will be the best way to save the lives of crew and keep the ship in the fight.

Today's automated damage control systems promise quick, clean, solutions to what is forever a chaotic problem. Damage control is not bloodless. It is and always will be a visceral battle for the survival of the ship and crew and no amount of automation will change that. This author—with over fifteen years of service in the surface warfare community—has never read an after-action report where a lack of manpower was not listed as a factor in combating a major conflagration on board a ship. On the contrary, in every case mentioned in this paper the entire crew worked beyond exhaustion and was still shorthanded. Likewise, the author has never participated in a readiness inspection where the uninterrupted power supplies (UPS) on which these automated systems rely did not fail. Automated systems certainly have their place and can be a significant improvement to the current system. The danger lies in believing that automation is a substitute for the right equipment and a robust and well trained crew.

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The roots of modern damage control were not home grown. They were not planted by the British Royal Navy. The systems of modern damage control came to the U.S. Navy courtesy of a former enemy, the Imperial German Navy engaged in fleet action in the North Sea in 1916. Innovative men saw the value of investing in ship survivability often at the cost of firepower and speed. It says a tremendous amount about the men of the General Board, the Bureau of Construction and Repair, and those in command of the fleet that they recognized the need to make U.S. warships stronger and innovated in such a way that the changes would last into this modern era. These were indeed men of vision and practicality. Thanks to them wars have been won, billions of dollars have been saved, and thousands of sailors have made it home from sea.

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